VISIT…

Chapter 8

Lubricants for Forest Product and Paper Machines*

The of the most critical aspects in maintaining the reliability of today's modern paper machine, Figures 8-1 and 8-2, is selecting a high-quality oil to lubricate key machine elements. Such a lubricant yields high productivity by lengthening the life of machine elements, typically bearings, gears, and couplings, while coping with the specific challenges of the machine's environment. Even though it may be operating in extreme temperatures and contamination sources, the paper machine oil is expected to have extended life.

The effect of improper lubricant selection can be significant. In many cases, the loss of a critical bearing can cause unscheduled downtime (always when it's most inconvenient), resulting in a loss of production and hiking equipment operating costs.

Even if a failure occurs when sufficient personnel are available to make a rapid repair, the cost of the premature machine element failure can be high in terms of the cost of replacement parts and added inventory costs incurred to maintain an excessive number of spares.

The current generation of paper machine oils is specially formulated for the unique requirements of the mill environment and ideally maximize machine life and reliability while minimizing maintenance costs.

Dryer Section Lube Critical

The most critical lubrication function is in the dryer section, where as many as several hundred roller bearings are present. These units are exposed to high temperatures due to their proximity to the superheated steam used in the drying process.

Compounding the effect of these high temperatures is the great likelihood that the oil system can become contaminated. Water is perhaps the most prevalent external contaminant, and the high probability of its presence in the oil system raises many concerns. These include accelerated oil breakdown, rust or corrosion problems, the poor lubrication properties of a water/oil mixture and potential chemical reaction with the additives used in formulating the paper machine oil. To complete this picture, the limited opportunity to change contaminated oil is notable, as the cost of the required downtime would be prohibitive in terms of production. Hence, the oil must maintain its lubricating properties over an extended period (as much as 30 years in some cases) without draining the system.

*Source: Exxon Company, U.S.A., Houston, Texas.

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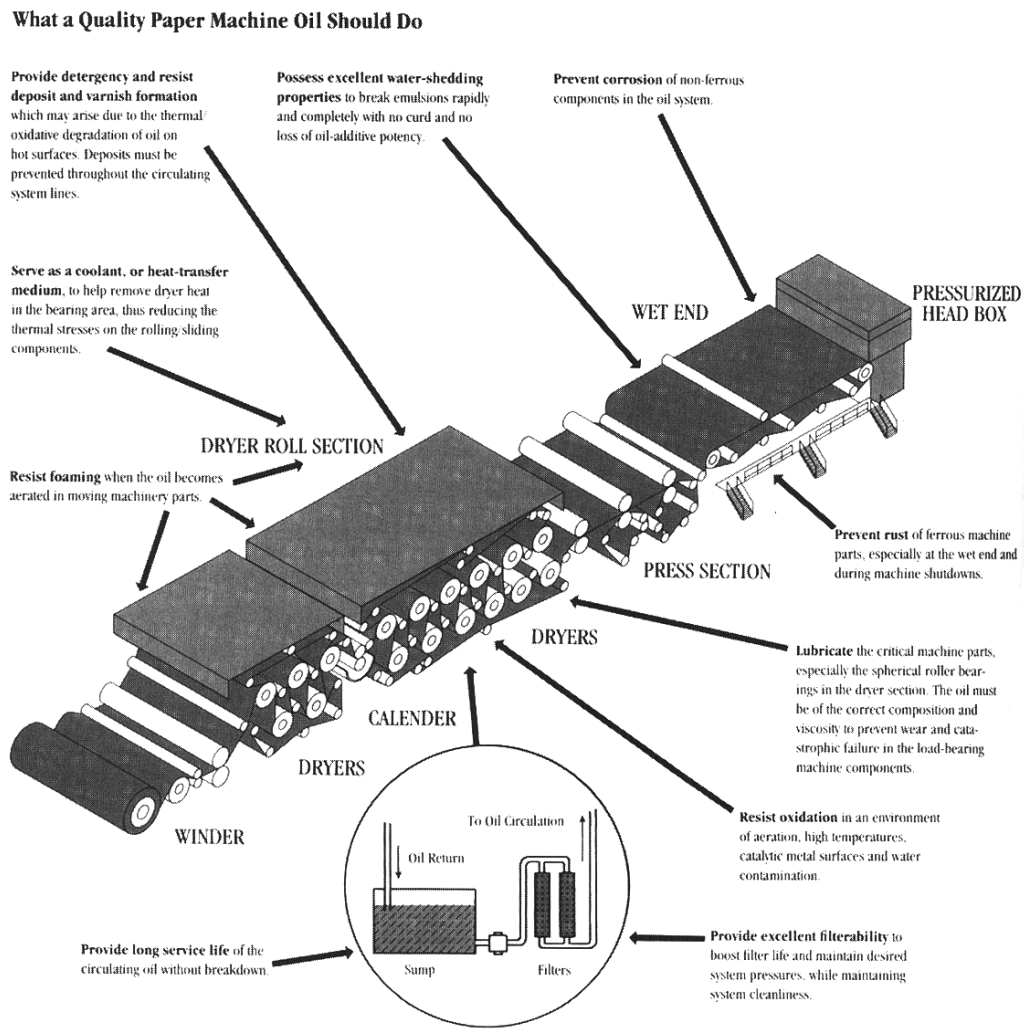
What a Quality Paper Machine Oil Should Do
Provide detergency and resist deposit and varnish formation which may arise due to the thermal/oxidative degradation of oil on hot surfaces. Deposits must be prevented throughout the circulating system lines.
Possess excellent water-shedding properties to break emulsions rapidly and completely with no curd and no loss of oil-additive potency.
Prevent corrosion of non-ferrous components in the oil system.
Serve as a coolant, or heat-transfer medium, to help remove dryer heat in the bearing area, thus reducing the thermal stresses on the rolling/sliding components.
WET END
PRESSURIZED HEAD BOX
DRYER ROLL SECTION
Resist foaming when the oil becomes aerated in moving machinery parts.
Prevent rust of ferrous machine parts, especially at the wet end and during machine shutdowns.
PRESS SECTION
DRYERS
Lubricate the critical machine parts, especially the spherical roller bearings in the dryer section. The oil must be of the correct composition and viscosity to prevent wear and catastrophic failure in the load-bearing machine components.
CALENDER
DRYERS
WINDER
To Oil Circulation
Oil Return
Resist oxidation in an environment of aeration, high temperatures, catalytic metal surfaces and water contamination.
Provide long service life of the circulating oil without breakdown.
Sump
Filters
Provide excellent filterability to boost filter life and maintain desired system pressures, while maintaining system cleanliness.

Figure 8-1. Typical paper machine.

MODERN PAPER MACHINE (PM) OILS HAVE GROWN SOPHISTICATED

Thus, the modern PM oil has, as a matter of necessity, evolved into a sophisticated product meeting many diverse performance requirements. As a starting point, most commercial oils are blended from high-quality mineral oil basestocks with viscosities in the range of 160-320 cSt/40°C (760-1,760 SUS/100°F). Selected performance additives further enhance the oils in other non-viscosity related properties. A premium PM oil is formulated with most, if not all, of the following properties:

- Appropriate viscosity
- Oxidation stability

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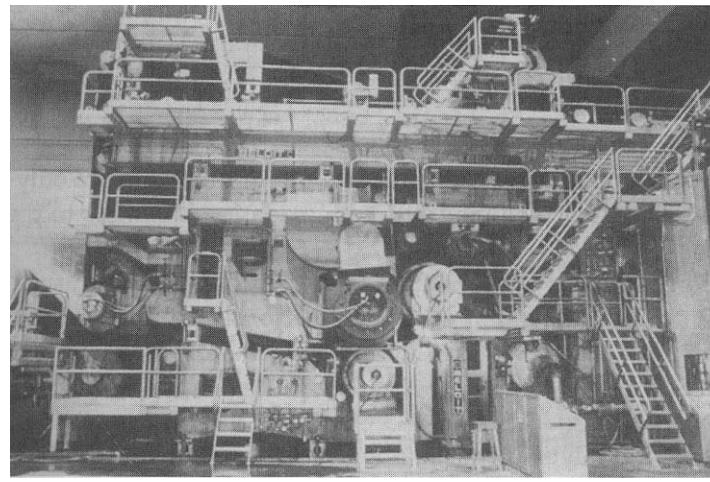

Figure 8-2. Paper machine.

- Rust protection
- Good water shedding traits
- Detergency
- Anti-wear protection
- Foam resistance
- Filterability through fine filters
- Dependable technical service
- Reliable local supply

A closer look at these properties is necessary to appreciate their value in a reliable PM operation.

Typically, most mills employ ISO 150 or 220 grade oils, although as machine oil temperatures have increased, there has been a trend toward higher viscosity oils (e.g., ISO 320). In older installations, operators should consider the size of the bearing oil exit piping before increasing oil viscosity.

Appropriate Viscosity

The selection of PM oil is crucial because its major function is to obtain the rated life of the bearings or gears. This is accomplished by maintaining an adequate oil film to prevent metal-to-metal contact in PM elements that otherwise would result in wear and metal fatigue.

The viscosity grade of oil should be selected on the basis of such factors as machine speed, oil temperature and bearing size. Bearing and oil suppliers often can supply details about specific methods that have been developed to estimate optimum oil viscosity based on the mill's specific conditions. Higher oil viscosity can provide longer bearing life, but that must be weighed against other considerations such as energy consumption, ease of handling and existing system constraints.

This is because higher viscosity oils present greater resistance to flow, which can be compounded by system piping that is partially obstructed by deposits that have built up over the years. Nonetheless, we find that mills often unknowingly use oils with a viscosity that is too low. This can occur when upgrading of machinery results in changed ma-

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chine operating conditions whose corresponding impact on system lubrication requirements has not been considered. The optimization of oil viscosity can many times provide a significant reduction in future maintenance cost by lengthening bearing life.

Oxidation Stability

The need for long oil life requires that PM oil formulations not only be based on a high quality base oil, but also be inhibited with oxidation inhibitors to prevent rapid oil breakdown.

Oil oxidation results in the formation of system deposits, varnishes and corrosive by-products that can markedly diminish system performance. Because in-machine testing is both risky and impractical, premium PM oils are generally formulated using long-term laboratory oxidation tests designed to simulate the oxidative conditions in a PM. The most common of these is the ASTM D-943 Oxidation Test which exposes the oil to high temperature, oxygen, catalytic metals and water.

In this severe test, PM oil life typically ranges between 1,000 and 1,600 hours. While there is no direct correlation between this test and PM oil performance, oils with lives in this range have generally provided good field service over the years. As the trend to hotter running dryer action continues, the need for oils with superior oxidation resistance will continue to grow.

Rust Protection

This is an essential property of any circulating oil, but it is especially important in the PM application where local humidity is high and where water is likely to enter the lubrication system. Ideally, rust protection is needed both when the oil is in contact with the metal surfaces and during short periods of PM shutdown.

Suitable rust inhibition capabilities are almost universally provided by most leading PM oils, while the longer-term "humidity environment" often protection often requires the careful selection of an advanced rust inhibitor technology.

Demulsibility

The ability to shed water is a key property of PM oils and is also related to the very wet conditions in which these oils are forced to perform. If significant amounts of water are introduced into the lubrication system, it is essential that the oil release the moisture quickly. This is especially important in wet-end oil circulation systems, where copious quantities of water are present. A good PM oil will provide this water-shedding capability and give a clean break between water and oil in the system sump, where the water can then be drained from the system.

Detergency

Protection against harmful deposit formation cannot solely be provided by oxidation inhibitors in a PM oil. This is because high local temperatures can exist in the steam-heated dryer roll bearings and result in thermal decomposition of the oil.

To combat this decomposition process, quality PM oils are formulated with detergent additives that act at the metallic bearing surface to prevent deposit build-up or coking.

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While non-detergent oils have been used in the past, their use may cause long-term bearing life to be sacrificed as a result of carbon build-up in bearing housings. Nowadays, it is often this detergency property which distinguishes a PM oil from similar industrial circulating oil types, such as turbine or hydraulic oils.

Anti-wear Protection

While the lubrication requirements of rolling and sliding contact bearings are primarily dependent on maintaining an adequate oil viscosity, PM oils are frequently used in other applications in and around the PM.

In light- to moderate-duty gear applications, it is sometimes desirable to provide some supplemental anti-wear protection, and PM oils thus are commonly formulated with this need in mind. Selection of the type of anti-wear additive is extremely important because the additive must tolerate the presence of water, i.e., minimize any possible reaction with water.

Foam Resistance

Often, air is carried in the oil system, and if the oil is not appropriately inhibited, foam and possibly an oil overflow situation can develop. For this reason, quality PM oils generally incorporate additives that can minimize foam formation and facilitate the release of captured air.

Filterability

Many mills, in an effort to reduce the level of abrasive contaminants circulating with the oil into bearing housings, routinely filter these oils through full-flow filters. The types and cleaning efficiencies of these filters vary widely among mills.

The smallest pore-size filtration systems, however, can range down to six microns. While most oils will filter without significant additive depletion at this level of filtration, in some instances the life of the filter elements has varied dramatically, depending on oil composition.

Careful selection of PM oil additives can alleviate this concern, and excellent filtration characteristics are now achievable. Oil filtration often depends on oil temperature, the presence of water or other contaminants, and flow rates. When considering oil filtration systems, it is best to consult both the oil supplier and filter manufacturer regarding the most cost-effective route to required system cleanliness.

A second aspect of filterability is the ability of a cold oil to flow through these filter elements upon startup. In many mills, plugged filters are often encountered upon startup due to materials collected on filters from cold oil. This problem can also be addressed by appropriate oil formulation technology.

Technical Service

Even with the highest quality PM oil formulations, the harsh conditions that a PM oil must endure will often lead to unique site-dependent concerns. It is then essential that your oil supplier has experts that can assist in developing solutions. This calls for a dedicated supplier whose people are familiar with the operation and needs of the paper industry customer.

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The PM oil supplier also should be willing to provide support even when there are no immediate problems. Your supplier should be able to provide some or all of the following, depending on your mill's specific needs: oil analysis programs, lubricant recommendations, surveys, training programs and a complete line of products for other mill lubrication needs.

Technical support capability of the oil supplier is of extreme importance to the paper industry. The oil is only as good as the organization that stands behind it.

Local Supply

The final factor in the PM oil quality equation must include the capability for effective local supply. Without rapid access to product supply in the event of an emergency, the best PM lubricant is worthless. It cannot protect bearings if it is not in or near your mill. A reputable oil supplier should be willing to work with your mill to establish the most appropriate supply network to meet your needs.

Clearly, dependable production in the modern paper mill requires more than excellent equipment. The machinery, operating under complex conditions of temperature and the threat of contamination, needs oils that are often diverse and complex.

The papermaker is therefore well advised to seek out an oil supplier who not only formulates a sophisticated, premium PM oil with all the above traits in mind, but also places skilled technical staff at the service of the papermaker. The effort pays off in longer machine life and more consistent and economical operations—which ultimately translates into a more profitable end product.

TERESSTIC N PAPER MACHINE OILS

TERESSTIC N 150 and 220 have proven themselves many times over in the paper industry. Advanced oxidation inhibitors help prevent premature bearing failure and increase the life of the oils. Outstanding detergency helps keep deposits from building up inside machinery, and excellent filterability makes TERESSTIC N 150 and 220 oils ideal for today's circulating systems and smaller filters.

Excellent water separability (demulsibility) at typical sump operating temperatures and dependable corrosion protection round out the balanced performance of TERESSTIC N paper machine oils.

TERESSTIC N 320 is *specifically formulated* to maximize the reliability of dryer roll bearings and other equipment where oil temperatures can exceed 93°C(199°F).

TERESSTIC N 460, an ISO 460 viscosity grade lube, equals or surpasses synthetic-base oils in the critical areas of oxidation, rust and corrosion inhibition, demulsibility and detergency—at a fraction of the cost.

See Table 8-1 for typical inspections and test results pertaining to these lubricants. Due to their versatility, TERESSTIC N oils are often recommended for other applications around the mill—gear boxes and pump bearings, among others. This facilitates lube oil consolidation.

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Table 8-1. TERESSTIC N Paper Machine Oil

TERESSTIC N Typical Inspections				
Grade	**150**	**220**	**320**	**460**
ISO viscosity grade	150	220	320	460
Color, ASTM D 1500	3.0	3.0	3.5	3.5
Viscosity:				
cSt @ 40°C, ASTM D 445	147.0	230.0	320.0	427.0
cSt @ 100°C	14.5	19.0	24.3	29.2
SUS @ 100°F, ASTM D 2161	764.0	1163.0	1703.0	2510.0
SUS @ 210°F	77.4	96.8	121.0	146.0
Viscosity index	97	97	97	97
Gravity, ASTM D 1250				
Specific @ 15.6°C(60°F)	0.8905	0.8950	0.899	0.9024
Flash point, ASTM D 92,				
COC, °C(°F)	254(489)	264(507)	279(534)	288(550)
Pour point, ASTM D 97,				
°C(°F)	-9(16)	-9(16)	-9(16)	-9(16)
Four-ball wear test, ASTM D 2266				
40kg, 600 rpm, 150°C(302°F),				
1 hr, scar diam, mm	0.5	0.5	0.5	0.5
Water separability				
ASTM D 1401	pass	pass	pass	pass
Rust test, ASTM D 665 A/B				
Distilled water	pass	pass	pass	pass
Synthetic sea water	pass	pass	pass	pass
Copper strip corrosion, ASTM D 130,				
3 hrs @ 100°C(212°F), rating	1	1	1	1
Detergency, panel coker test,				
277°C(530°F)	——— trace deposit only ———			

TERESSTIC N EP PAPER MACHINE OIL

Although most paper machine wet and dry ends can be satisfactorily lubricated with a single premium paper machine oil, the press section may require an EP gear oil designed to protect heavily loaded components, such as the extended nip presses, crown control roll hydraulic systems, and integral gear systems. The paper industry has expressed growing interest in the convenience of a single product that combines the detergency and high temperature performance of a paper machine oil with the EP perforce of a premium gear oil. This would permit cost-effective consolidation of lubricant inventories and reduce the possibility of lubricant misapplication.

TERESSTIC N EP (Table 8-2) provides heavily loaded systems components with a *double* benefit—60-lb Timken EP performance *plus* detergent and thermal properties sig-

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nificantly superior to those of conventional gear oils. TERESSTIC N EP meets or exceeds the requirements of the major paper machine manufacturers in anti-wear and EP performance, oxidation and thermal stability, detergency, rust protection, demulsibility and filterability. It also meets AGMA and USS 224 Gear Oil requirements.

Table 8-2. TERESSTIC N EP typical inspections.

TERESSTIC N EP Typical Inspections **Grade**	**150**	**220**	**320**
ISO viscosity grade	150	220	320
Color, ASTM D 1500	3.5	5.0	5.0
Viscosity:			
cSt @ 40°C, ASTM D 445	147	230	320
cSt @ 100°C	14.5	19.0	24.3
SUS @ 100°F, ASTM D 2161	764	1163	1703
SUS @ 210°F	77.4	96.8	121
Viscosity index	97	97	97
Gravity, ASTM D 1250			
Specific @ 15.6°C(60°F)	0.8905	0.8950	0.8990
Flash point, ASTM D 92, COC, °C(°F)	254(490)	264(507)	279(535)
Pour point, ASTM D 97, °C(°F)	-9(15)	-9(15)	-9(15)
Timken OK load, lbs	60	60	60
4-Ball EP, ASTM D 2783			
Load wear index, kg	48	48	48
Weld point, kg	250	250	250
FZD D 5182, pass stage	12	12	12
Water separability, ASTM D 1401	pass	pass	pass
Rust test, ASTM D 665 A/B			
Distilled water	pass	pass	pass
Synthetic sea water	pass	pass	pass
Copper strip corrosion, ASTM D 130,			
3 hrs @ 100°C(212°F), rating	lb	lb	lb
Detergency, panel coker test, 277°C(530°F)	——— trace deposit only ———		

CYLESSTIC STEAM CYLINDER AND WORM GEAR OIL

CYLESSTIC is the trademark for a line of steam cylinder oils formulated to meet exacting lubrication requirements in the forest products and paper industries. Of course, they find numerous applications in other industry sectors as well. And, although officially classified as steam cylinder lubricants, the compounded grades also provide excellent protection against wear in worm gear drives and are recommended for engines operating on saturated or slightly superheated steam at either high or low pressures. CYLESSTIC lubricants are also used where cylinder wall condensation occurs. The non-compounded grade is the recommended oil for use with high-pressure superheated steam systems.

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Because of their high viscosity indexes, the CYLESSTIC oils are well adapted to wide variations in temperature.

Grades

CYLESSTIC steam cylinder oils are available in four viscosity grades. These grades conform to the International Standards Organization (ISO) viscosity classification system. Three grades—CYLESSTIC TK 460, TK 680, and TK 1000—are compounded with acidless tallow and a tackiness agent to provide lubrication under the wet conditions encountered with saturated steam. The fourth grade—CYLESSTIC 1500—is not compounded, but is formulated specifically for the dry, high-temperature operating conditions associated with superheated steam. It also meets the requirements for a straight mineral SAE 250 gear lubricant.

Steam Cylinder Lubrication

All four grades are suitable for use where separation of the lubricant from condensate is desirable. CYLESSTIC TK 460 is recommended for low-pressure saturated steam systems. CYLESSTIC TK 680 and CYLESSTIC TK 1000 are recommended for high-pressure saturated steam systems. The tackiness agent incorporated in the compounded grades functions to reduce consumption, to provide better adhesion to the cylinder walls, and to provide better separation from exhaust steam.

Atomization

Unlike most moving parts, which are lubricated by the direct application of grease or oil, steam cylinders are generally lubricated by a mist of oil carried by the steam. Oil is injected into the steam by means of an atomizer inserted into the steam line ahead of the steam chest. As the steam flows past the open end of this atomizer at relatively high velocity, it picks up droplets of oil discharged from the atomizer tube. Under the proper conditions, the oil mist produced in this manner is diffused throughout the incoming steam. All moving parts in contact with the steam receive a share of lubricant.

To be effective, the oil mist must be diffused in minute particles. Oversize droplets settle out of the steam and may not reach the more distant areas to be lubricated. In other locations, they may accumulate in excessive quantities, leaving residues on the wearing surfaces. Thorough atomization is essential, therefore, to complete lubrication of the cylinders. Proper atomization is partly dependent upon characteristics of the oil, such as viscosity. An oil that is too heavy does not break up into droplets that are sufficiently small. On the other hand, an oil that is too light will not carry the required loads.

The CYLESSTIC oils, which have inherently good atomization characteristics and are available in four viscosity grades, Table 8-3, can be applied in the correct viscosity for complete atomization and for effective protection to the lubricated surfaces.

Worm Gear Lubrication

In addition to meeting difficult steam engine lubricating requirements, CYLESSTIC, in the compounded grades, is an excellent lubricant for many worm gears. CYLESSTIC TK 460, CYLESSTIC TK 680, and CYLESSTIC TK 1000, respectively, meet the viscosity requirements of the American Gear Manufacturers Association (AGMA) specifications for (7) Com-

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Table 8-3. CYLESSTIC steam cylinder and worm gear oils.

Typical Inspections
The values shown here are representative of current production. Some are controlled by manufacturing specifications, while others are not. All may vary within modest ranges.

CYLESSTIC Grade	TK 460	TK 680	TK 1000	1500
ISO viscosity grade	460	680	1000	1500
AGMA lubricant number	7 comp	8 comp	8A comp	—
Gravity, ° API	21.8	21.7	21.5	20.5
specific at 15.6°C (60°F)	0.9230	0.9236	0.9248	0.9309
Viscosity				
cSt at 40°C	429	627	925	1600
cSt at 100°C	30.1	37.8	46.7	64.2
SSU at 100°F	2289	3384	5017	8802
SSU at 210°F	147	184	227	312
Viscosity index	99	97	93	92
Pour point				
°C	-7	-7	-1	-1
°F	20	20	30	30
Flash point				
°C	271	279	288	313
°F	520	535	550	595
Fire point				
°C	316	321	338	352
°F	600	610	640	665
% compounding	5	5	4	—

pounded, (8) Compounded, and (8A) Compounded gear lubricants.

Worm gears, threaded shafting, and other such lubricant applications are characterized by a high degree of sliding motion under heavy pressure. The compounded CYLESSTIC grades have extra oiliness that provides good lubrication, which minimizes wear in machine elements of this type.

EXXON SAWGUIDE BIO SHP SYNTHETIC LUBRICANT

Here, interestingly, is a lubricant that fits into the categories biodegradable, synthetic, and forest product-oriented. Because of its rather unique application, we have elected to discuss it within the forest product chapter. Figures 8-3 and 8-4 shed light on this fact.

Exxon Sawguide Bio SHP is a synthetic biodegradable lubricant specifically developed to provide superb, trouble-free lubricating performance in demanding sawmill operating environments. Formulated with a synthetic basestock and a proprietary additive package, Exxon Sawguide Bio SHP is readily miscible in water, has exceptional oxidation

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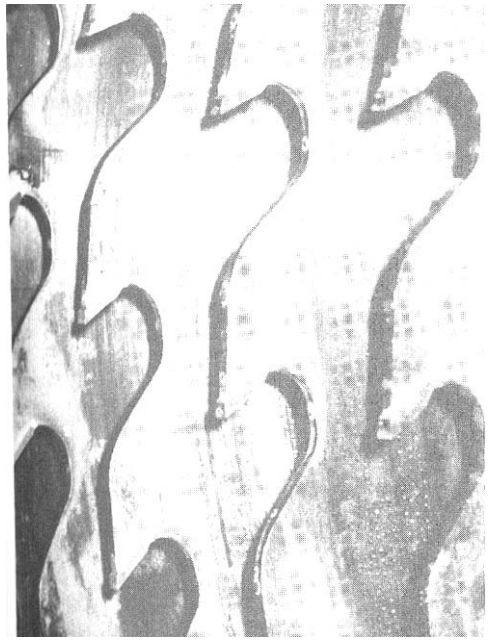

Figure 8-3. Exxon Sawguide Bio SHP keeps equipment running cleaner, longer.

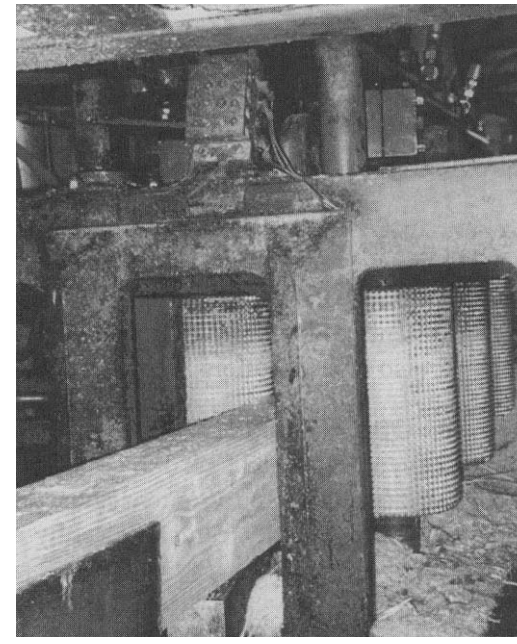

Figure 8-4. Exxon Sawguide Bio SHP specifically formulated for dependable lubrication in demanding sawmill operations.

stability and anti-wear performance, and protects against rust in wet environments. The outstanding performance properties of Exxon Sawguide Bio SHP can improve operational efficiencies and extend equipment life compared to mineral-base lubricants.

Table 8-4. Exxon Sawguide Bio SHP synthetic lubricant.

Typical Inspections

The values shown here are representative of current production. Some are controlled by manufacturing specifications, while others are not. All of them may very within modest ranges.

Kinematic viscosity @ 40°C, ASTM D 445	110
Timken OK load, ASTM D 2282, lbs	85
Rust, ASTM D 665	Pass
Emulsion, 15 min, 54°C, ASTM D 1401, ml water	0
Tack	Pass
Biodegradable, calculated	75
Compatibility with Marinus oil	Pass
Storage stability	Pass
Density @ 15°C, ASTM D 4052-95, g/ml	0.9239
Pour Point, °C	N/A
Appearance	Hazy

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Reduced Deposits and Wear

Conventional petroleum-base lubricants tend to mix with water and sawdust to produce a gummy residue that clogs the sawguide and overheats the equipment. This often necessitates time-consuming equipment shutdowns. In contrast, the excellent oxidation stability and high solvency of Exxon Sawguide Bio SHP synthetic lubricant help minimize sawguide clogging, thereby reducing unscheduled downtime.

Dependable Performance at Temperature Extremes

Exxon Sawguide Bio SHP provides reliable lubrication protection over a wide range of seasonal and operational temperatures. It has good flow characteristics in cold weather and excellent oxidation and thermal stability at very high operating temperatures. The product also has exceptional storage stability, even at high ambient temperatures.

Reduced Oil Consumption

The synthetic basestock of Exxon Sawguide Bio SHP has a strong natural affinity for metal surfaces. The product's tenacious adherence to lubricated parts, combined with its relatively high viscosity, can significantly reduce lubricant consumption.

Biodegradability

In addition to superb lubricating performance, Exxon Sawguide Bio SHP also has a distinct environmental advantage. It is classified as "readily biodegradable," as defined by the OECD 301B CO2 Evolution Test (Modified Sturm Test).

TERESSTIC SHP SYNTHETIC PAPER MACHINE OILS

To help meet increasingly more demanding operating conditions it is essential to use circulating oils capable of withstanding increasingly higher operating temperatures.

Exxon's TERESSTIC SHP circulating oil, Table 8-5, are specially formulated to meet the demands of modern calendar rolls and other dry-end paper machine equipment applications where bearing temperatures in excess of 100°C(210°F) are often experienced.

TERESSTIC SHP is a super-premium, synthetic-base ashless circulating oil. Compared with mineral-base oils, TERESSTIC SHP provides superior high-temperature performance and service life. The polyalphaolefin basestock also has an inherently high viscosity index and low pour point, which permit excellent retention of oil film thickness across a wider temperature range and better energy efficiency at cold startup.

TERESSTIC SHP provides excellent anti-wear performance and good extreme-pressure performance under moderate-load conditions. It is fortified to protect against rust, provides excellent demulsibility and resists foaming and air entrainment.

OTHER LUBRICANTS FOR THE PAPER AND FOREST PRODUCTS INDUSTRY

For hydraulic and gear oils used in this industry, see chapters dealing with these lubricants. These oils include SPARTAN Synthetic EP, NUTO H. Greases include RONEX, Polyrex and Lidok; refer to the chapter on grease (Chapter 9).

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Table 8-5. Typical inspection and test data for TERESSTIC SHP lubricants.

TERESSTIC SHP* Typical Inspections Grade	150	220	320	460	680
ISO viscosity grade	150	220	320	460	680
Color, ASTM D 1500	<1	<1	<1	<1	1
Viscosity:					
cSt @ 40°C, ASTM D 445	159	211	333	466	680
cSt@ 100°C	20.0	24.7	34.7	45.0	59.9
SUS @ 100°F, ASTM D 2161	845	1165	1715	2477	3200
Viscosity index, ASTM D 2270	145	147	148	151	150
Gravity, specific, ASTM D 1250					
@ 15.6°C(60°F)	0.863	0.845	0.859	0.861	0.860
Flash point, ASTM D 92,					
°C	276	272	280	286	282
°F	529	522	536	547	540
Pour point, ASTM D 97,					
°C	-42	-42	-36	-30	-30
°F	-44	-44	-33	-22	-22
FZG gear test,					
minimum stages passed	12	12	12	12	12
Water separability,					
ASTM D 1401	pass	pass	pass	pass	pass
Rust test, ASTM D 665 A/B	pass	pass	pass	pass	pass
Copper strip corrosion,					
ASTM D 130,					
3 hrs @ 100°C(212°F), rating	1A	1A	1A	1A	1A

*The grades listed are the most commonly used; TERESSTIC SHP is also available in ISO viscosity grades 32 through 1500.

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